Space Weather Technical Forecast

Issued on Saturday, 09 July 2022 at 01:11 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1 Radio Blackout observed, Chance of further such events. CME generated, awaiting further imagery for analysis.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity rose sharply to become Moderate in the past 24 hours, with a long-period M2.5 X-ray flare recorded at GOES16 from AR3053 at 08/2048UTC. Prior to this, activity had been very subdued, with only occasional small C-class flares observed.

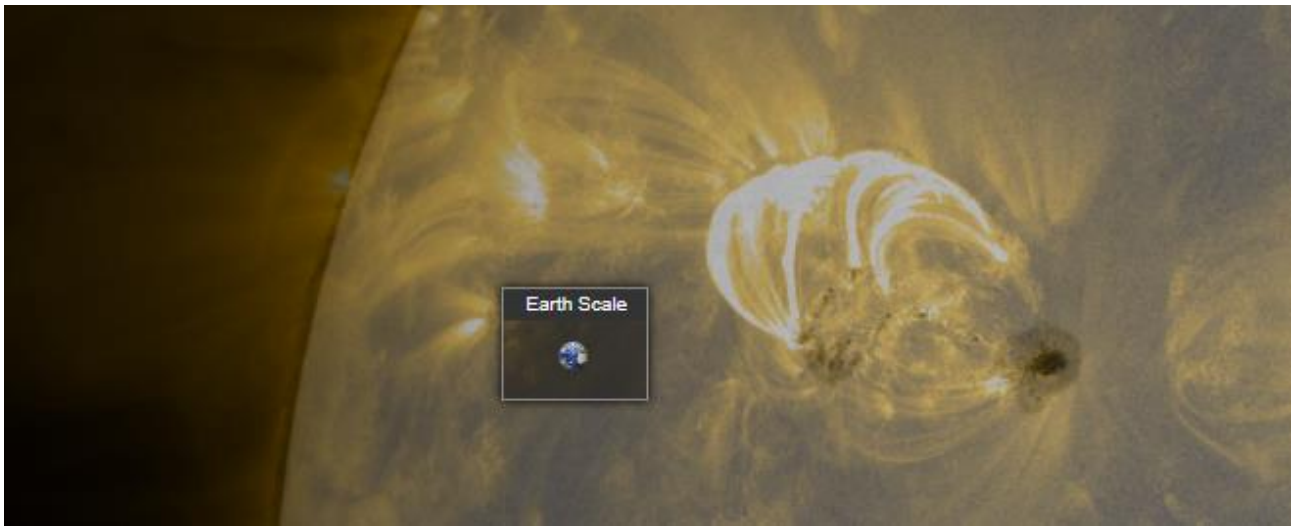


Figure 0: False-colour AIA 171 and HMIIF composite image of the 08/2048UTC X-ray flare from AR3053, the largest and magnetically most complex region on the Sun, with the Earth shown for scale. Image processing courtesy of helioviewer.org.

There are now five numbered sunspot regions on the disc. The largest and most complex was the group that produced the M-class flare, AR3053. This presented as an Eki/Beta by the period's end, with some proliferation of its intermediate spots early in the day replaced by a spreading tendency with time. Also of note on the Earth-facing side in terms of complexity were AR3055 to its east, which manifested as a Dai/Beta, with growth in its intermediate spots for a time, with these then migrating into the leading cluster. The other groups on the disc were smaller and simpler, with AR3046 an Hsx/Alpha; AR3051 a Csi/Beta; and AR3052 a Cro/Beta. AR3054 faded to plage in the period.

There are currently numerous large filaments on the disc, with the southeast quadrant in particular harbouring two large features that each span roughly 20 degrees on the solar disc. There were no signs on instability in these in the reporting period, however they will become increasingly relevant should they lift off in the coming few days and will be monitored. Other areas of note included the southwestern limb, which saw a non-Earth directed prominence lift-off.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

The large M-class flare was both long-period and showed accompanying dimming in AIA 211, which are expected to mean that some form of Coronal Mass Ejection has been produced, with early imagery suggesting that this is mainly east of the Sun-Earth line, to be confirmed. No Earth-directed CMEs have been observed in available imagery over the past 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, showed influence from CME for much of the period, perhaps segueing into some residual influence from CH97/+ for a time before a sector change to negative (towards the sun) into the UTC evening.

The solar wind speed showed a roughly level trend in the 24 hours, ranging between 375 and 425km/s, before a late decline to 350km/s. The solar wind density was somewhat erratic and often slightly elevated, with an absolute peak of 35ppcc and an overall slightly reducing trend. The IMF was elevated in the CME, with an early peak of 22nT, although fortunately the north-south component often showed a co-aligned bias with the Earth's field to mitigate against geomagnetic effects, with a range of -12nT to +18. The phi angle showed a gradual drift from negative (towards the sun) through positive until 08/1830UTC in a CME-like regime, whereupon a more settled change to negative occurred, perhaps implying the end of any influence from CH97/+.

The net effect of the above solar wind measures was an overall fall from early G1 intervals in the 00-03 and 03-06UTC intervals, becoming more readily Quiet into the UTC evening.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES-16, remained at Background levels throughout the period.

The high energy electron flux (greater than 2MeV) has been at Normal Background levels. The corresponding 24-hour integrated electron fluence remained well below the Active (1e8 integrated pfu) threshold on a roughly level trend. Observed fluence was 1.45e6 integrated pfu at 09/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to remain Low, but with a daily Chance of M-class flares. A progressive slight increase is possible in the four days, as while no significant regions leave, up to two may return over the eastern limb.

Solar Wind / Geomagnetic Activity: There is a small residual chance of some influence from the shock of the 05 July CME early on day one, although effects are now likely to be muted for the long transit time - if even present. In addition, the CME from the aforementioned M2.5 flare is as yet unanalysed, but may carry an Earth-directed component. No other CMEs feature.

No obvious sources of fast wind then feature in the remainder of the forecast, with solar winds perhaps peaking at the time of writing for the period as a whole.

Activity should therefore wane through the period, with an initial Slight Chance of Minor Storm G1 should any 05 July CME influence materialise, before becoming reliably quiet by the new UTC working week. Note that this does not account for any further CME influence.

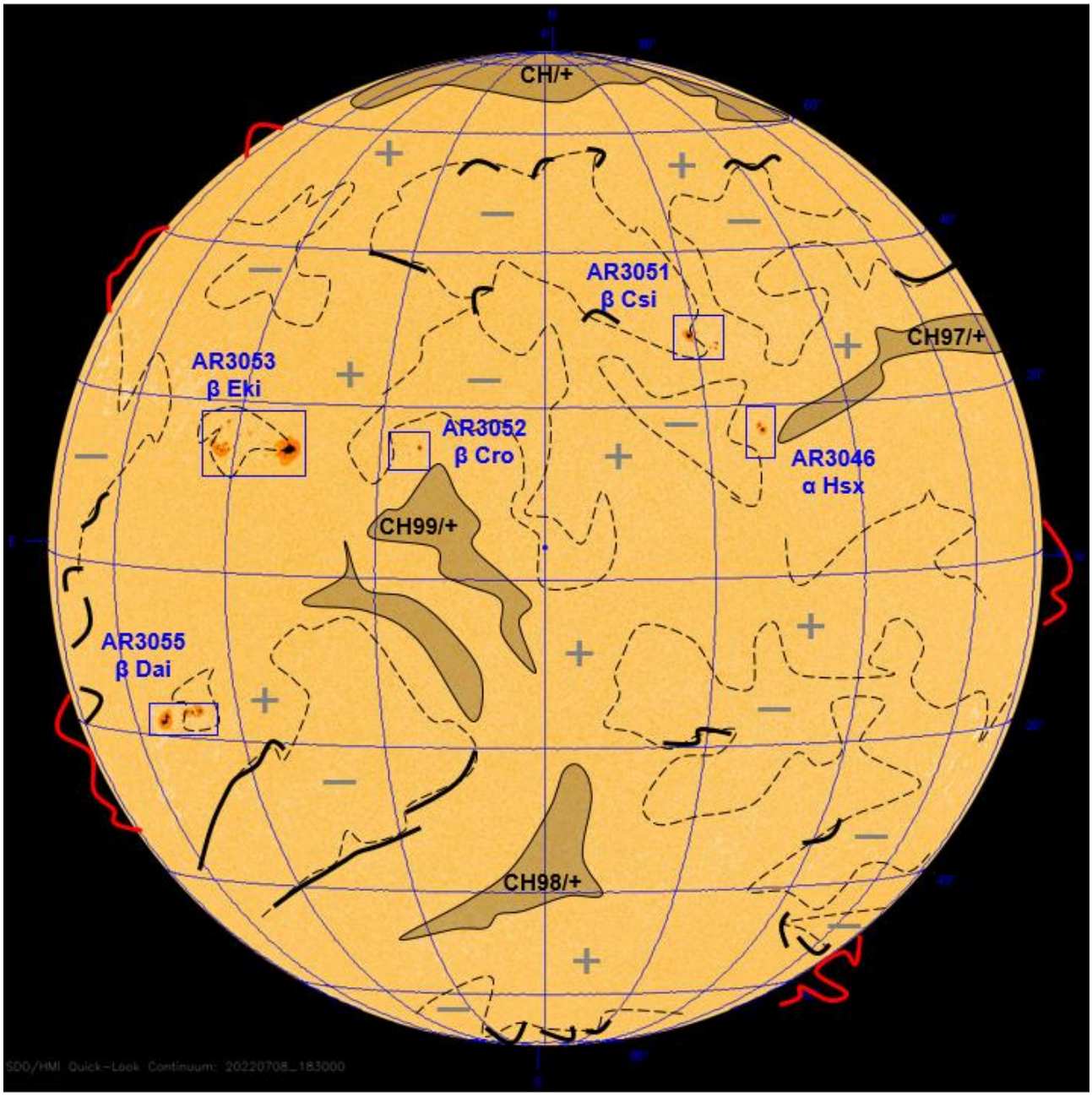
Energetic Particles / Solar Radiation: In the absence of any significant sunspot development, the high energy proton flux (greater than 10 MeV) is likely to remain at Background levels, but with a very slightly rising tendency with the westward progression of the front-side large sunspot groups.

The high energy electron flux (greater than 2MeV) may increase slightly into the new working week, however confidence is low, with 24-hour integrated fluence still considered most probably to remain below Active throughout.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 1. Solar Analysis Valid 08/1830UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

A low confidence glancing blow is possible at the start of day one (Saturday 09 July) from a CME that left the Sun on 05 July, from AR3047. This CME was difficult to assess as it was faint and contaminated by a far-sided CME which was visible at the same time. However, it gave a faint partial halo in SOHO imagery. Any effects are now likely to be muted for the long transit time - if even present.

As well as the above, a CME from the 08 July M2.5 flare from AR3053 was generated, with this as yet unanalysed, but potentially carrying an Earth-directed component. No other CMEs feature.

The sector change to negative in the wake of the recent CME may signal the end of CH97's influence, and as such no further coronal holes are expected in the period. STEREO A does hint that either a minor SSBC to positive may occur in two days' time, or perhaps a minor positive coronal hole may influence Earth, however the source is not clear and the size of disturbance is currently modest, less than 400km/s.

Activity should therefore wane through the period, with an initial Slight Chance of Minor Storm G1 should any 05 July CME influence materialise, before becoming reliably quiet by the new UTC working week. Note that this does not account for any further CME influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

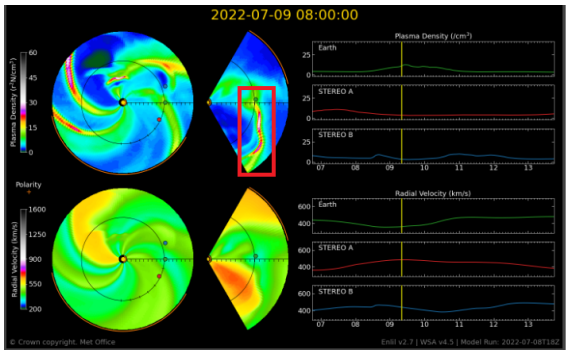
Geomagnetic Activity - Earthbound Coronal Mass Ejections

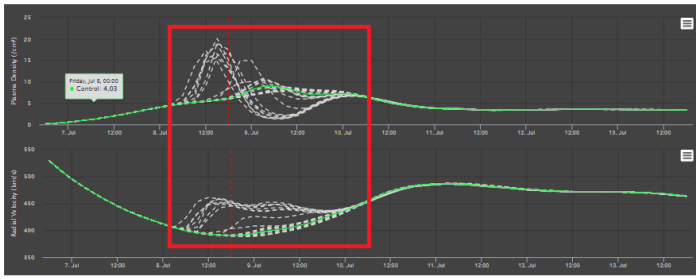
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
05/0934 UTC	Partial halo	AR3047	SW Quadrant	530 km/s	Imminent if present	Overdue, low confidence - Limited shock expected

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 2: Latest MOSWOC Enlil run and ensemble, suggesting a residual risk of marginal incidence from the 05 July partial halo shock CME. This feature is now overdue and may have passed the Earth to the south and west of the Sun-Earth line.





Radio Blackouts - X-Ray Flares:

There are now five sunspot regions on the disc, with AR3053 by far the largest and most complex, and finally delivering in what has otherwise been a fairly quiescent disc. Also of note in terms of complexity, if not yet activity, are AR3055 to its east, which appears as a Dai/Beta, and also AR3051, a Csi/Beta, although prior to the M2.5 from AR3053 there was little activity of any note.

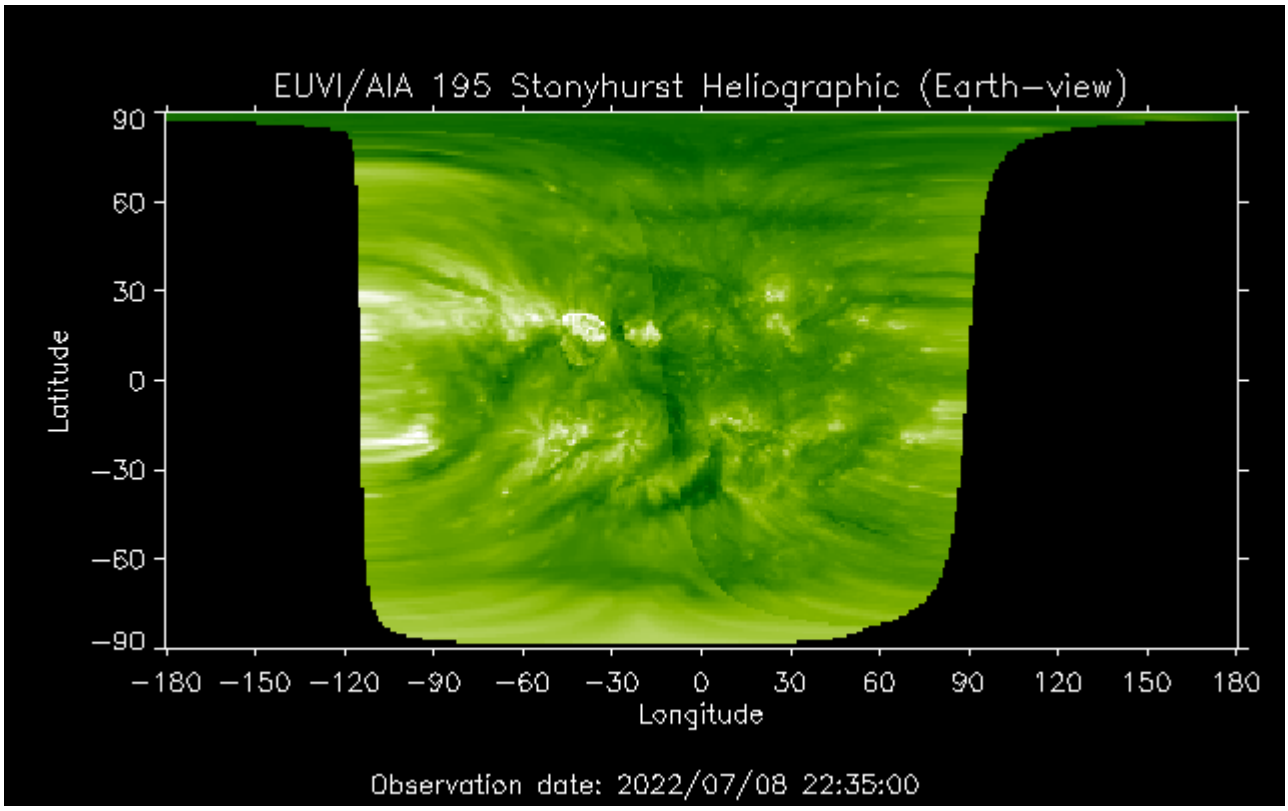
Solar activity is Likely to remain Low, but with a daily Chance of M-class flares. A progressive slight increase is possible in the four days, as while no significant regions leave the Earth-facing side of the Sun, up to two may return over the eastern limb.

X Ray Flares / **Probability**	**Level**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)** / **(%)**	**Day 2 (00-24 UTC)** / **(%)**	**Day 3 (00-24 UTC)** / **(%)**	**Day 4 (00-24 UTC)** / **(%)**
Active	**R1-R2 M Class**	No	30	30	30	30
Very Active	**R3 to R5 X Class**	No	5	5	5	5

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 3: Available EUVI 195 imagery from STEREO A suggests at least some survivals over the eastern solar horizon that may contribute to a slightly rising risk of further X-ray flares in the forecast period.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at Background levels, and will most likely remain at this level through the period, in the absence of any significant sunspot development.

There is a very slight upward tendency in risk through the four days, however this is not sufficiently different from the 5% shown to display.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) is currently at Normal Background levels. Recurrence methods are not liekly to be useful in the forecast given the changes in CH97/+ and its predecessor between rotations, as well as the heavily transient-polluted forecast and recent past. Flux levels ought to exhibit any response to the recent high speed stream in the very near future, probably establishing a diurnal trend before the UTC weekend is out that may then see out the period unaltered.

The chances of Active fluence being realised should probably peak by the new working week in the absence of any further CME activity, however even at peak they will most likely fall comfortably short of Active.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	No	1	10	30	30
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.